Clinical Medicine

Use of Intravenous Pyelography in Blunt Trauma—A Reappraisal

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The role of intravenous pyelography (IVP) in the evaluation of blunt abdominal trauma is controversial. Major renal injuries have occasionally been reported in the absence of hematuria, but the test is not always accurate, is expensive and has potential morbidity. By reviewing the charts of 150 consecutive patients seen in an emergency department who had IVP for blunt abdominal trauma, we evaluated the ability of clinical and laboratory findings to predict IVP findings, the incidence of abnormal findings on IVP and the number of times IVP affected patient management. Only one patient's management was found to be clearly affected by the results of the IVP. We feel, therefore, that IVP should be reserved in cases of blunt abdominal trauma for patients with gross hematuria and those with microscopic hematuria and suggestive clinical findings. The absence of hematuria should preclude the use of IVP unless there are other exceedingly strong clinical findings.

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The diagnosis of urinary tract injury consequent to blunt trauma can be difficult, and the role of pyelography in which the dye is given intravenously (IVP) has been the subject of controversy. Some authors have proposed that IVP should be done in any patient with a suggestive injury, in light of the fact that significant renal or other urinary tract injury can occur in the absence of positive findings on urinalysis.[1-3] Others have noted the relative infrequency with which the results of IVP change the management of patients with blunt trauma and have suggested that it be reserved for patients with more specific indications.[4-6] Various clinical findings have been proposed as either necessary or sufficient indications for IVP following blunt trauma. These include any or all of the following: a suggestive mechanism of injury, back or flank pain, gross or microscopic hematuria, x-ray film findings of lower rib fractures, lumbar spine fractures or transverse process fractures in the upper lumbar spine.[7-9]

This study was designed to evaluate the usefulness of IVP in diagnosing urinary tract injuries in patients with blunt abdominal trauma and to determine whether any particular clinical or laboratory findings would correlate with the presence of abnormalities on IVP. We hypothesized that clinical and laboratory findings would not differentiate patients with abnormalities on IVP from those patients in whom posttraumatic IVP is normal. We also hypothesized that the results of IVP would rarely affect the clinical management of patients with blunt trauma because few renal or urinary tract injuries determined by IVP studies would require surgical or other specific intervention, and such injuries, when present, would be most likely to occur in the presence of associated injuries that would mandate a surgical procedure.

Patients and Methods

We did a cohort study by reviewing the charts of 150 consecutive patients seen at the UCLA Emergency Medicine Center from April 29, 1981, to March 28, 1983, following blunt trauma for whom intravenous pyelography was done. No formal rules governing when to do an IVP were in force at the time the patients were seen. In general, an IVP was done following blunt trauma if there was any degree of hematuria, a suspicious mechanism of injury, clinical or x-ray film findings suggestive of upper urinary tract injury or if a patient required an abdominal operation for other reasons. There were also no strict criteria for doing a cystogram or a urethrogram. In general, cystography was done if an IVP showed a possible bladder injury, in patients with severe pelvic fractures and in patients with gross hematuria and pelvic pain. A urethrogram was usually done on patients with gross blood at the meatus, a free-floating prostate, severe pelvic fractures or in whom a Foley catheter could not be easily passed into the bladder.

By retrospective chart review we collected clinical information on each patient, including age, sex, mechanism of injury, presence or absence of suggestive signs and symptoms (including back pain, groin pain, abdominal tenderness and costovertebral angle tenderness), gross and microscopic hematuria, findings on plain x-ray films (transverse process, rib fractures or both), IVP results, performance of an associated abdominal procedure and hospital admission. Each element that could not be gathered by retrospective chart review was considered unknown and excluded from analysis. For example, we did not assume that back pain was absent if it was not specifically recorded on the chart. On the other hand,

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objective findings, such as the presence or absence of transverse process fractures on x-ray study, which could be subsequently determined by x-ray film review, were always recorded as either positive or negative. We separated patients with urinary tract abnormalities on IVP from those whose IVP showed normal kidneys, ureters and bladder. IVPs that showed only pelvic hematoma were classified as normal. We compared a cohort of patients with abnormal IVP with the others to determine if any of the previously mentioned clinical or laboratory findings could distinguish between the two groups. Finally, we looked at each of the individual cases with an abnormal IVP to determine whether the IVP findings changed the clinical course of the patient and, if so, how.

Statistical Methods

Statistical analysis for nonparametric data was done by χ^2 testing. Comparisons of continuous variables between the two groups were evaluated by analysis of variance. A P value of .05 or less was considered statistically significant. Sensitivity, specificity and positive and negative predictive values were defined in the standard manner.

Results

The patients' mean age was 28.4 ± 1.1 years, and 67% were male. The mechanism of injury of these patients is listed in Table 1. Most were involved in a motor vehicle accident (74%), either as the driver or passenger of an automobile or motorcycle or as a pedestrian; 16% were injured in falls.

Table 2 presents the clinical characteristics of these patients. When positive or negative documentation of their signs and symptoms was present in the medical record, the majority of patients had back pain, groin pain and abdominal tenderness. In all, 41% had costovertebral angle tenderness. Gross hematuria was present in 15% of patients. Transverse process fractures and lower rib fractures were present in 16% and 27%, respectively. All of these clinical signs and symptoms, except rib fractures, were more frequent in patients with abnormal IVP. Except for gross hematuria, however, these differences did not reach statistical significance, and in no case did the presence or absence of individual findings accurately predict IVP findings.

Table 3 presents a comparison between the amount of hematuria in the patients stratified by abnormal and normal IVP results. Of patients with abnormal IVP, 11% had fewer than 10 erythrocytes per high-power field, as opposed to 30% of patients with normal IVP. Of patients with abnormal IVP, 44% had gross hematuria as opposed to 14% of patients with normal IVP. All degrees of hematuria were more frequent in those patients with abnormal IVP; only the difference, however, in the rates of gross hematuria was statistically significant ($P = .02$). The sensitivity, specificity and positive and negative predictive values of gross hematuria for abnormalities as seen on IVP were 44%, 87%, 17% and 96%, respectively. The presence of microscopic hematuria of 10 or more erythrocytes per high-power field with regard to these same variables was 89%, 30%, 7% and 98%, respectively.

The clinical findings, IVP results and clinical course of the nine patients with multiple trauma and abnormal emergency department IVPs are presented in Table 4. Four patients were felt to have a renal contusion, two had extravasation of contrast material from the kidney and there was one instance each of unilaterally decreased excretion (felt to be possibly due to right renal vascular trauma), bladder rupture and displacement of the left kidney inferiorly by what was felt to be a large superior hematoma. All patients but one were managed without surgical treatment. One patient with possible extravasation was discharged from the emergency department after about 20 hours of observation. In two instances, renal injury was confirmed by other tests, one each by renal scan and renal angiogram. The patient whose IVP showed displacement of the left kidney possibly because of a large hematoma superiorly had a liver-spleen scan done that was interpreted as equivocal. That patient was taken to the operating room and had normal findings at laparotomy. All nine of these patients had at least one positive sign or symptom, gross hematuria or transverse process fracture.

Only patients whose intravenous pyelogram showed a defined injury to the kidneys, ureter or bladder were considered to have abnormal IVPs. In addition to the 9 patients with the

TABLE 1.—*Mechanism of Injury in 150 Patients With Multiple Trauma Who Had Intravenous Pyelogram in an Emergency Department*

Mechanism of Injury	Number (%)
Automobile accident	59 (39)
Auto *v* pedestrian	27 (18)
Motorcycle accident	26 (17)
Fall	24 (16)
Assault	6 (4)
Other	8 (5)

TABLE 2.—*Clinical Characteristics of 150 Patients With Multiple Trauma Who Had Intravenous Pyelogram (IVP) in an Emergency Department*

Clinical Characteristic	IVP Results (%) Abnormal	Normal	Total	P
Age, years*	26.7±2.3	28.5±1.1	28.4±1.1	NS
Sex, male	4/9 (44)	97/141 (69)	101/150 (67)	NS
Back pain	4/4 (100)	70/88 (80)	74/92 (80)	NS
Groin pain	2/2 (100)	24/81 (30)	26/83 (60)	NS
Abdominal tenderness	8/9 (89)	74/131 (56)	82/140 (59)	NS
CVA tenderness	4/5 (80)	18/49 (37)	22/54 (41)	NS
Gross hematuria	4/9 (44)	19/141 (13)	23/150 (15)	<.05
Transverse process fracture	3/9 (33)	21/141 (15)	24/150 (16)	NS
Lower rib fracture	1/9 (11)	40/141 (28)	41/150 (27)	NS
Abnormal cystogram	1/3 (33)	1/27 (4)	2/30 (7)	NS

CVA=costovertebral angle, NS=not significant

*Mean ± standard error of the mean.

TABLE 3.—*Amount of Hematuria in 150 Patients With Multiple Trauma Who Had Intravenous Pyelogram (IVP) in an Emergency Department*

Hematuria (RBCs/hpf)*	IVP Results Normal, No. (%)	Abnormal, No. (%)	Total, No. (%)	P
<10	42 (30)	1 (11)	43 (29)	>.05
≥10	99 (70)	8 (89)	107 (71)	>.05
≥20	83 (59)	7 (78)	90 (60)	>.05
≥30	72 (51)	6 (67)	78 (52)	>.05
≥50	62 (44)	6 (67)	68 (45)	>.05
Gross hematuria	19 (14)	4 (44)	23 (15)	=.02

*RBCs/hpf=erythrocytes per high-powered field.

noted abnormalities, 11 had IVPs that showed a pelvic hematoma. In none of these patients was any specific diagnostic test or therapy initiated as a result of this finding.

Of the 150 patients, 30 had a cystogram done. Two of these were abnormal, showing bladder rupture. In one of these patients, the IVP also showed bladder rupture. The other patient was a 35-year-old man with gross hematuria whose intravenous pyelogram was interpreted as normal. His bladder rupture was treated surgically, with no other indications for a surgical procedure. There were no abnormal urethrograms obtained on any of these patients.

Discussion

It has been suggested that an IVP should be done almost routinely in patients with blunt trauma because of the occasional presence of significant renal injuries in patients who do not have any degree of microscopic or gross hematuria or significant clinical findings.[2,3] Most large series of patients receiving an IVP for multiple trauma, however, have failed to document the usefulness of this test.[4-6] An IVP is obtained on many patients with positive findings, and even when abnormalities are shown on IVP, rarely do these affect patient management.

McDonald and co-workers[4] showed that IVP results were not accurately predicted by clinical and laboratory findings (urinalysis) in 209 patients with blunt abdominal trauma. Of these patients, 18 had abnormal IVPs, and of these only 6 had gross hematuria, while the other 12 had microscopic hematuria. Only 9 of the 18, however, had abdominal exploration, and in 8 of these cases evaluation of associated injuries was the indication for a surgical procedure. Thus, IVP affected the management in only 1 of the 209 cases; other details of this patient's clinical and urinalysis findings are not separated out in the report.

Guice and colleagues[5] found that 13 of 156 patients (8%) had abnormal IVP after blunt trauma. Microscopic or gross hematuria was the indication for IVP. While 3 of 119 patients with microscopic hematuria had abnormal IVP, therapy was changed by IVP findings in none of them. All five patients who required further evaluation on the basis of IVP had gross hematuria, including the only patient of the 156 (0.6%) who required surgical therapy.

Levitt and associates reported 17 abnormal IVPs in 105 patients (16%) undergoing pyelography for blunt abdominal trauma.[6] Only 3 of these 17 required urologic surgical intervention, and all 3 had gross hematuria, suggestive clinical findings and at least one associated injury. In none of 83 patients without gross hematuria was the clinical course affected by IVP.

Sturm and Perry evaluated 92 patients with thoracic and lumbar transverse process fractures for the presence of associated injuries.[7] Urologic surgical injuries were absent in the 41 patients who did not have hematuria and were present in only 1 of 39 patients with microscopic hematuria. This was in contrast to the presence of such injuries in 4 of 12 patients with gross hematuria.

Griffen and co-workers, on the other hand, suggested that "all patients sustaining abdominal trauma should have an IVP regardless of whether of not hematuria is present."[2] This statement is based on the fact that in their review of 18 patients with presumed blunt renal trauma (as defined by one or more of abnormal IVP, presence of hematuria or operative findings), four did not have hematuria, two of whom underwent operative intervention. One of these two had a spleen removed, but no surgical procedure related to the genitourinary system; thus, only one patient with "renal trauma" without hematuria had clinical treatment changed by IVP. The authors do not clearly state how many patients had IVP during the time this one case was discovered, although they suggest there were 152 patients with "blunt abdominal trauma" seen at their institution during this period. Thus, even in this series from which the authors make an exceedingly strong statement about the value of IVP, the yield of this procedure seems to have been extremely low.

We reviewed 150 consecutive IVPs done at our institution in patients with blunt trauma because we suspected that the results of the IVPs usually did not change patient management. We attempted to find clinical markers that might help differentiate between patients with normal and abnormal IVPs so as to define reasonable criteria for doing IVPs following blunt trauma, and thus to limit the number of patients who need this test. While it is important to identify patients requiring specific care of major renal injuries, we noted that IVP is not only expensive (a total of $41,700 was spent on the 150 studies in our series) and time-consuming but carries significant risk (anaphylaxis, renal failure, delay to operation), and thus its costs might well outweigh its benefits if it only rarely contributes positively to patient management.

TABLE 4.—*Clinical Findings, IVP Results and Clinical Course in Nine Patients With Multiple Trauma and an Abnormal IVP in an Emergency Department (ED)*

Patient	Age, yr	Sex	IVP Result	Back Pain	Groin Pain	Abdominal Tenderness	CVA Tenderness	Gross Hematuria	Transverse Process Fracture	Clinical Course
1	18	♀	Possible right renal vascular trauma	?	?	No	?	No	Yes	Renal scan abnormal; conservative treatment
2	19	♂	Left renal contusion	?	?	L	L	No	No	Conservative treatment
3	24	♂	Extravasation, left lower pole	?	?	L	L	Yes	No	Conservative treatment; repeat IVP normal
4	25	♀	Bladder rupture	?	Yes	L	?	Yes	Yes	Foley catheter
5	26	♀	Possible right renal contusion	?	?	Yes	?	No	No	Conservative treatment
6	28	♂	Possible extravasation left kidney	Yes	Yes	R	No	No	No	Discharged from ED
7	29	♂	Right renal contusion	Yes	?	R	R	Yes	Yes	Conservative treatment
8	29	♀	Right renal contusion	Yes	?	R	R	Yes	No	Renal angiogram shows right lower pole laceration; conservative treatment
9	42	♀	Displaced left kidney, large hematoma superiorly	Yes	?	Yes	?	No	Yes	Equivocal liver-spleen scan; normal findings on laparotomy

CVA=costovertebral angle, IVP=intravenous pyelography, L=left, R=right, ?=questionable or equivocal

Our findings seem to show the lack of usefulness of IVP in most patients in whom it is done in the setting of blunt trauma. While there were no standard criteria for doing IVP during the time patients entered into this study were seen, IVP was generally done in patients for indications that are similar at many institutions, including the presence of microscopic or gross hematuria, a significant mechanism of injury, clinical findings such as groin or costovertebral angle (or both) pain and tenderness and significant plain x-ray film findings such as transverse process or lower rib fractures. Of 150 IVPs carried out for such indications, only 9 were abnormal. Of greater significance is the fact that of these 9 abnormal IVPs, none influenced therapy.

We had only limited success in differentiating patients with normal and abnormal IVPs. The best marker for separating these two groups was the presence or absence of gross hematuria, which was found in 4 of 9 (44%) patients with, as compared with 19 of 141 (44%) patients without, abnormal findings on IVPs ($P = .02$). The absence of gross hematuria, however, did not rule out an abnormal IVP (56% false-negatives), and its presence was not proof of abnormal IVP, since 19 of 141 (14%) patients with normal IVPs, including one with bladder rupture, had gross hematuria. Interestingly, one of nine patients with abnormal IVPs had fewer than 10 erythrocytes per high-power field on urinalysis, substantiating the belief that the absence of significant microscopic hematuria does not preclude an abnormal IVP. Nevertheless, 42 of 43 patients without even microscopic hematuria—fewer than 10 erythrocytes per high-power field—had normal IVP, suggesting that the absence of microscopic hematuria has an excellent negative predictive value for genitourinary tract injury as seen on IVP.

Besides gross hematuria, other clinical, laboratory and x-ray film findings are traditionally used in decision making regarding doing IVPs. While groin pain, abdominal tenderness and costovertebral angle tenderness were all more frequent in patients with abnormal IVP, these findings were only recorded as present or absent in a few of the patients in this series. It is impossible to meaningfully extrapolate from this small number to the entire group of patients in the series, as it is impossible in a study based on retrospective chart reviews such as this one to know whether or not these findings were positive in the much larger number of patients for whom they were not recorded.

In retrospect, it is apparent that IVP was not useful in many of the patients in our series. It could indeed be argued that it was virtually never useful and was misleading in the one patient who had abdominal surgical intervention for an intraperitoneal bladder rupture discovered by cystography. This is not to say that IVPs should never be done following blunt abdominal trauma. IVPs are important in patients undergoing exploratory laparotomy following trauma, to document the presence of two functioning kidneys if indeed surgical findings indicate the need for a nephrectomy on one side. IVPs are generally thought to be accurate in identifying renal lesions requiring surgical treatment, although they are clearly not always sensitive or specific in defining these lesions, as seen in the one patient in our series who did have an operation.

While there are no precise criteria to be gleaned from our study that would accurately identify all patients with abnormal IVP, or accurately exclude all patients with normal IVP, we suggest the use of significantly more stringent criteria in doing IVP following blunt abdominal trauma. We suggest that IVP should be done following blunt trauma in the presence of gross hematuria, or if there are 10 or more erythrocytes per high-power field on urinalysis in association with clinical findings suggestive of renal injury, including back pain, groin pain, transverse process fractures or a highly suggestive mechanism of injury such as a direct blow to the costovertebral area. Fewer than 10 erythrocytes per high-power field should exclude IVP except in the presence of very strong clinical indications. Additionally, IVP should be done in patients who will be undergoing exploratory laparotomy for other indications, so as to define the genitourinary tract anatomy and ensure the presence of two functioning kidneys. We think that the adoption of such criteria, which should thus be more stringent than those currently used at many institutions, would significantly decrease the number of IVPs done in this circumstance, while being highly unlikely to adversely affect the management of any patients.

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